Please consider the following abstract entitled "Free-Flying Magnetometer Data System" for presentation at the 18th Digital Avionics Systems Conference

Free-Flying Magnetometer Data System

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The **Free-Flying Magnetometer** (FFM) is an autonomous "**sensorcraft**" developed at the Jet Propulsion Laboratory (JPL) for the Enstrophy sounding rocket mission. This mission was a collaborative project between the University of New Hampshire, Cornell University and JPL. The science goal of the mission was the study of current filamentation phenomena in the northern auroral region through multipoint measurements of magnetic field. The technical objective of the mission was the proof of concept of the JPL FFM design and the demonstration of an insitu multipoint measurement technique employing many free-flying spacecraft. Four FFMs were successfully deployed from a sounding rocket launched from Poker Flats, Alaska on February 11, 1999. These hockey-puck-sized (80 mm diameter, 38 mm height, 250 gram mass) **free flyers** each carry a miniature 3-axis flux-gate magnetometer that output ±2 V signals corresponding to a ±60,000 nT measurement range for each axis. The FFM uses a synchronized four-channel ΣΔ Analog-to-Digital Converter (ADC) having a dynamic range of ±2.5V and converting at a rate of 279 samples/second/channel. Three channels are used to digitize the magnetometer signals to 17-bit (1.144 nT/bit) resolution. The fourth ADC channel is multiplexed for system monitoring of four temperature sensors and two battery voltages. The FFM also contains two sun sensors, a laser diode which emits a fan-shaped beam, a miniature S-band transmitter for direct communication to the ground station antennas, an ultra-stable Temperature Compensated Crystal Oscillator (TCXO) clock, an integrated data subsystem implemented in a Field-Programmable Gate Array (FPGA), a 4 Mbit Static Random Access Memory (SRAM) for data storage and Lithium Thionyl Chloride batteries for power. Communicating commands to the FFM prior to deployment is achieved with an infrared (IR) link. The FFM IR receiver responds to 9-bit pulse coded signals that are generated by an IR Light Emitting Diode (LED) in the payload for turning FFM power on or off and placing the FFM in a test mode or flight mode. The IR links are also used to synchronize (zero) the clocks onboard all the FFMs through a reset pulse originating from the payload GPS receiver that is issued when the FFMs are in flight mode. The FPGA based data subsystem manages continuous data collection from the four ADC channels and sun sensors, formatting and storing the data to SRAM, and controlling downlink transmission. The transmitter is powered only after a 2547 frame SRAM buffer has been filled (~ 5 minutes of data). The data is Viterbi encoded and sent to the S-band transmitter via a First-In-First-Out (FIFO) buffer who's output is clocked at 100 bits/second. After the 26-second transmission, the transmitter is turned off to reduce noise coupling to the sensitive magnetometer. The data subsystem control consists of a master state machine that performs data flow management and is interfaced through a prioritized interrupt scheme to state machines that service the ADC, sun sensors and transmitter FIFO. Continuous data collection prevents the missing of data during

microspacecraft
nanospacecraft
sciencecraft

cluster class mission
planetary magnetosphere

transmission and provides implicit time tagging of the data acquired by the ADC because of synchronization with the TCXO clock.

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